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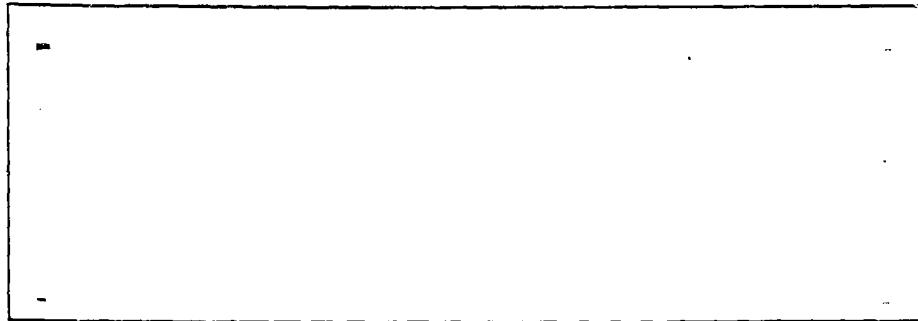


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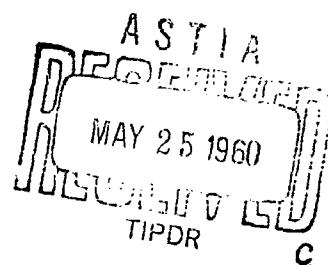
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8433 FALLBROOK AVENUE • CANOGA PARK, CALIFORNIA • DIAMOND 6-7171

TN-60-408

INFRARED BACKGROUND INVESTIGATION

R. E. Eisele

RAMO-WOOLDRIDGE  
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THOMPSON RAMO WOOLDRIDGE INC.  
CANOGA PARK, CALIFORNIA

Scientific Report No. 2  
Contract AF 19(604)3473

15 March 1960

Prepared  
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GEOPHYSICS RESEARCH DIRECTORATE  
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AIR RESEARCH AND DEVELOPMENT COMMAND  
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## I N D E X

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## INTRODUCTION

This is the second report to be issued on Contract 19(604)3473. This contract was issued by the Geophysics Research Directorate of the Air Force Cambridge Research Center to obtain data concerning the radiant intensity of the infrared sky background and to measure the amplitude of the sky gradient. As a part of this contract, a measurement field trip was made to Key West, Florida, during the month of June 1959, for the purpose of making sky background measurements in cooperative participation with IRMP 59/60. This report contains only the gradient measurements made on this field trip along with enough description of the instrumentation to understand the methods of obtaining the data. Immediately following this report, Report No. 3 will be issued describing the radiometric data obtained at Key West, after which will appear the 4th and final report which will include certain analyses of the data, a possible mathematical model, and some conclusions.

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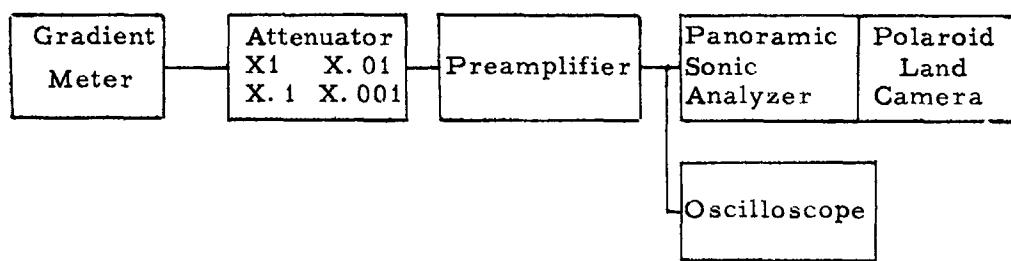
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## DESCRIPTION OF INSTRUMENTATION

The gradient data presented in this report was obtained with an instrument which can function as a radiometer or a gradient meter. Only the gradient meter function will be described here. Complete descriptions of the equipment design will be found in the reports appended in the reference list.

The method used to take gradients consists simply in developing an electrical function analogous to the background function and then performing a Fourier analysis of this electrical function. The electrical function is developed by scanning the background in a repetitive manner with a sensitive detector in a small field of view. The instrument presently used for this purpose scans in small circles up to 6 degrees in diameter by setting the primary collector off-axis and rotating it about the instrument axis. This produces circular scanning determined by the off-axis setting of the mirror. Fixed on-axis, in the focal plane, is a small lead sulfide cell. The focal plane is rotated by the off-set mirror and the cell output is proportional to the differences in intensity encountered in the circular path about the focal plane. The primary collector is a sphere mirror 4 inches in diameter with a focal length of 8 inches. The lead sulfide cell is .020 x .020 inches. Due to occlusion by a secondary mirror, the effective aperture is f/3.5. The instantaneous field of view is determined by the PbS cell and is 2.5 x 2.5 milliradians.

The block diagram below is descriptive of the complete system. The cell output is amplified by a preamplifier and fed directly into a Panoramic Sonic Analyzer. The input to the analyzer is observed on an oscilloscope to make certain that no limiting occurs in the preamplifier, and attenuators are provided to decrease the gain whenever necessary. The data is recorded by photographing the cathode ray tube of the analyzer with a Polaroid Land Camera.



The raw data obtained in this fashion gives voltage amplitude in terms of cycles per second and it is necessary to apply certain calibrations and correction factors to determine the amplitude in absolute radiance units and the frequency in terms of space units.

## DATA REDUCTION

In space frequency, the basic variable is inverse angular dimension (or linear) and the units are usually expressed as waves, or cycles, per radian. Waves per radian are the units which have been chosen as the frequency ordinate in presenting the data in this report. The fundamental space frequency, or 1st wave number, is determined by the length of one scan in radians. This is dependent upon the angular diameter of the scanning circle. The scanned circle is a small circle in the sky dome and its circumference in radians is given by

$$c = 2\pi \sin \frac{\theta}{2} \quad (1)$$

where  $c$  is the circumference of the scanned circle in radians

and  $\theta$  is the diameter of the scanned circle in degrees.

The fundamental is  $\frac{1 \text{ wave}}{2\pi \sin \frac{\theta}{2}}$  or 3.04 waves/radian  
for  $\theta = 6$  degrees

Converting this to cycles per second is simply a matter of multiplying by the scan velocity. The mirror rotates at 10 R.P.S. therefore it makes 1 revolution in 0.1 seconds. From (1), the scan length is 0.3282 radians and the velocity is 3.288 radians per second. 3.04 waves/radian  $\times$  3.288 radians per second gives 10 cps for the fundamental space frequency of 3.04 waves/radian. The second harmonic, or wave number 2 will be 6.04 waves/radian at 20 cps, etc. The relationship between cycles per second and waves per radian is shown in Figure 1.

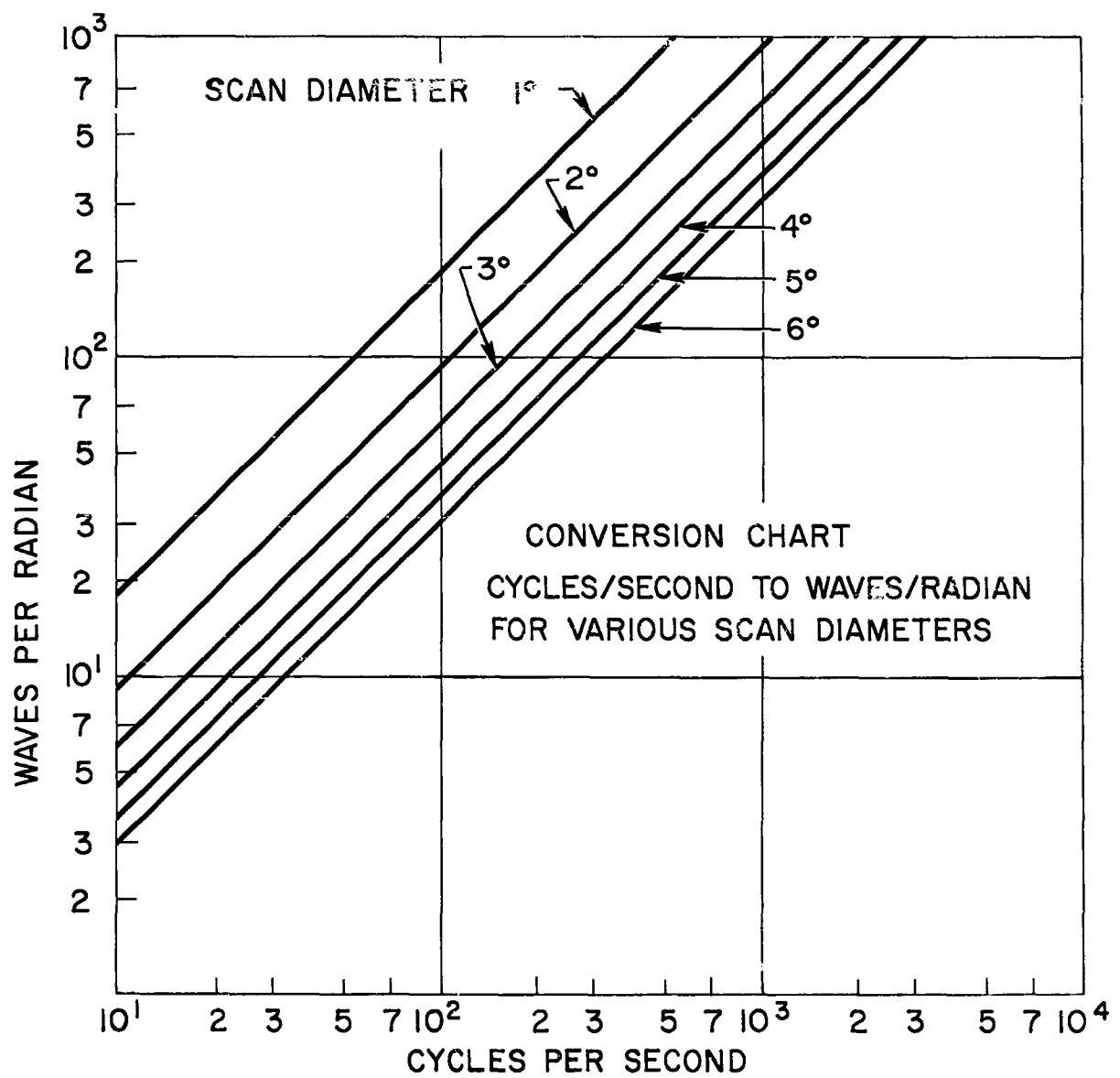
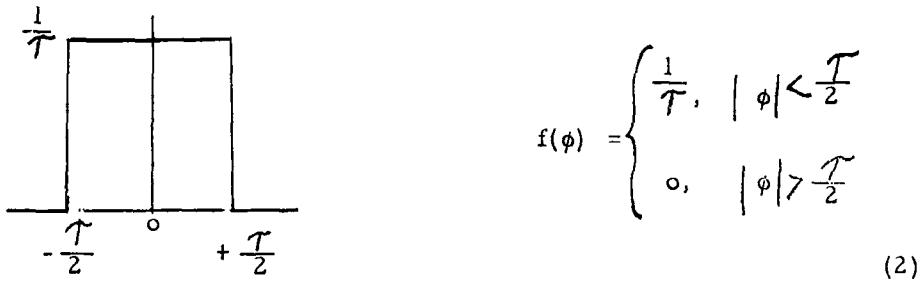


Figure 1. Conversion Chart - Cycles per Second to Waves per Radian

The resolution of the gradient meter can be affected by the angular subtent of the field stop, the optical resolution of the system, the time response of the detector, and the bandwidth of the analyzer. These will be discussed in order to develop the method used in calibrating the instrument and reducing the data to absolute energy units.

The field stop is the aperture in a focal plane which limits an instrument to a certain definite angular field of view. In this case, the cell is the field stop, it is square, and subtends a field of view  $2.5 \times 2.5$  milliradians. The field stop acts as a low pass, space frequency filter and has the same frequency transfer function as an electrical square pulse, with the exception that the basic variable is inverse angle ( $\phi$ ) instead of inverse time ( $t$ ). If the field stop is represented by



then the transform is:

$$F(\omega) = \frac{\sin(\frac{\omega T}{2})}{(\frac{\omega T}{2})} \quad (3)$$

where

$$\omega = \frac{2\pi n}{T}$$

$T$  = width of slit in radians

$n$  = the harmonic number of the frequency where the transfer function is evaluated.

Inspection of (3) shows that when  $\omega = \frac{2\pi}{\theta}$ ,  $F(\omega)$  becomes zero. This occurs when  $n = 1$ . Zeros occur for  $n = 1, 2, 3$ , etc.

To say that  $n = 1$  means that the angular wavelength passing across the slit is equal to the angular width of the slit. If, for instance, a slit is carried across an intensity variation whose angular wavelength is equal to the angular slit width, there will be no change in the total light transmitted by the slit. The slit, therefore, suppresses this variation entirely and will do so when the slit width is equal to two, three, four, etc., wavelengths. For these wave numbers, the transfer function is zero. It can be seen that the general form of the transfer function is  $\frac{\sin \theta}{\theta}$ . This curve produces minus values which should be interpreted in the transfer function as a 180 degree phase reversal of the component. Since the gradient meter is sensitive to amplitude only and not phase, it is better to consider the general transfer function as the absolute value of  $\frac{\sin \theta}{\theta}$ , with all values being plotted in a positive direction. This general transfer function for any slit is plotted in Figure 2.

The frequency transfer function for the field stop in the gradient meter is illustrated in Figure 3. At  $n = 1$ , there is one wave per 2.5 milliradians field stop width. This is a frequency of 400 waves per radian. Taking  $n = 0.5$  produces 200 waves per radian. Figure 3 shows the field stop transfer function only to the first null at 400 waves per radian because it is not used much beyond the point where it drops below 70%. After this point, the drop-off becomes so steep that the frequencies are attenuated below the instrument noise level. The curve in Figure 3 is used to correct the data in the same fashion that any electrical filter function is used.

The frequency transfer characteristic for the blur circle, or angular resolution, of the optical system is treated in exactly the same manner as for the field stop. The blur circle is round, however,

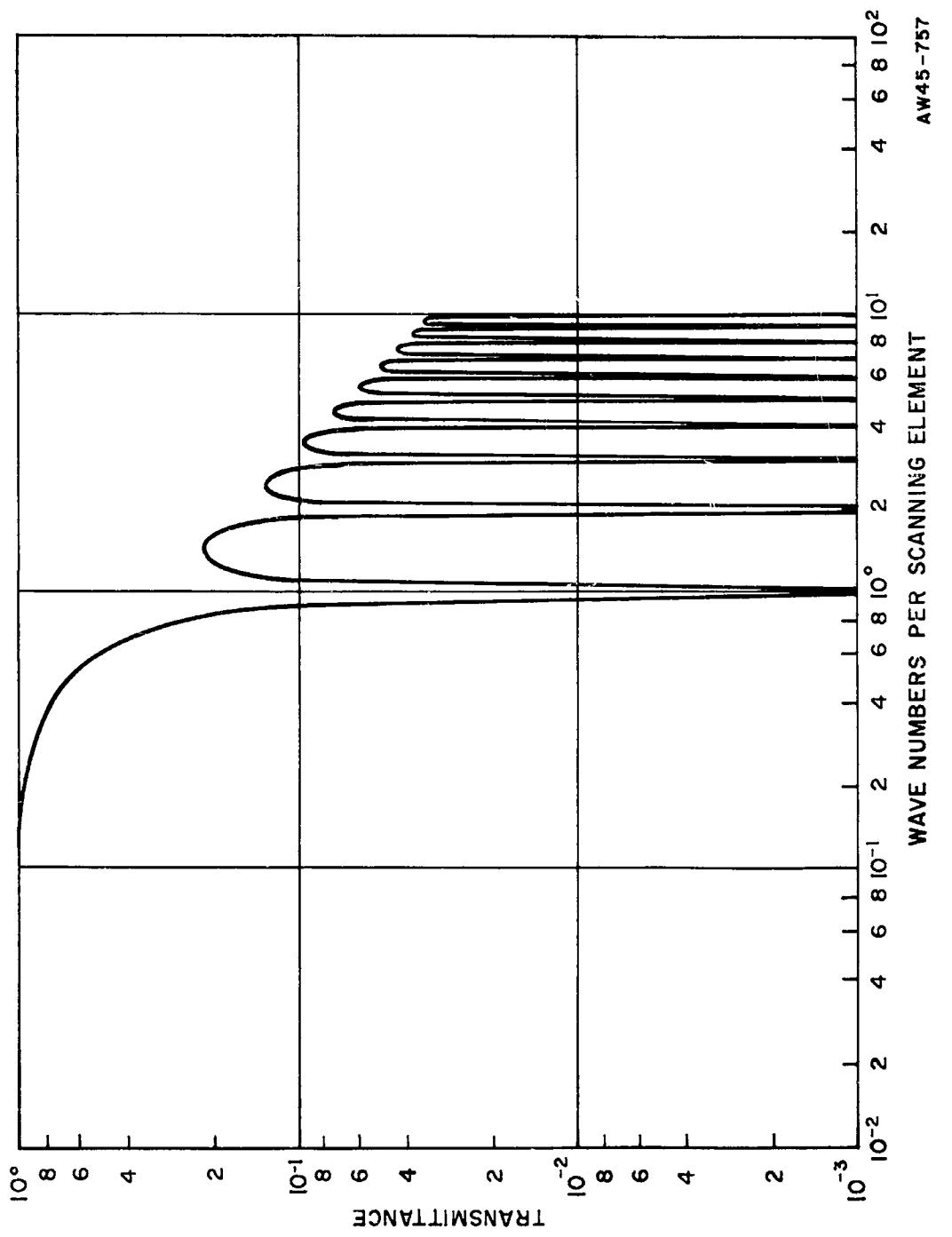


Figure 2. Generalized Field-stop Frequency Transfer  
Characteristics for any Slit-Width.

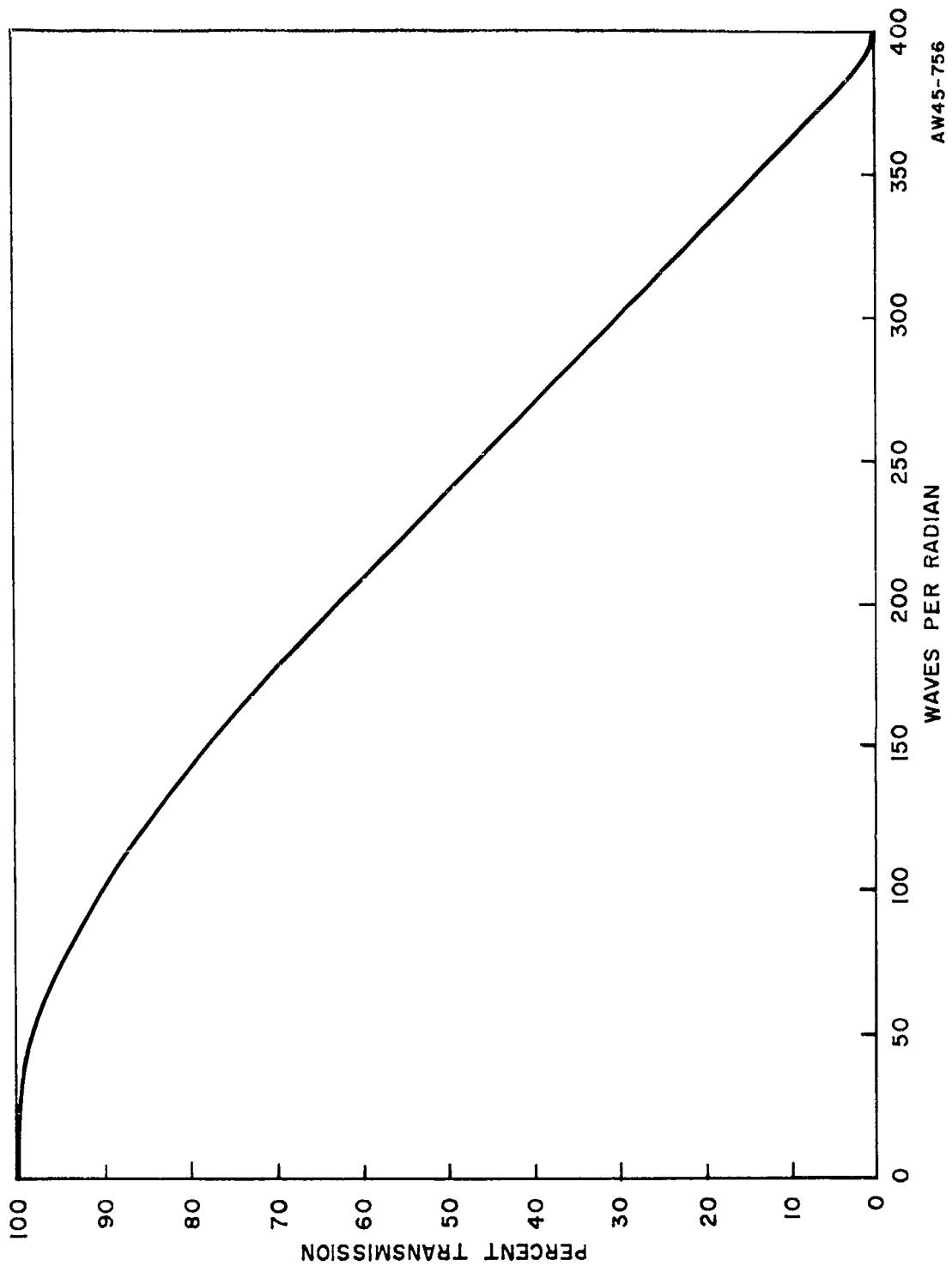
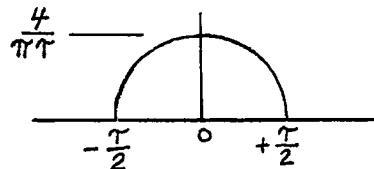


Figure 3. Gradient Meter Frequency Transfer Characteristic.

instead of square, and, by measurement, is 0.5 milliradians in diameter. The characteristic function is usually given as,

where

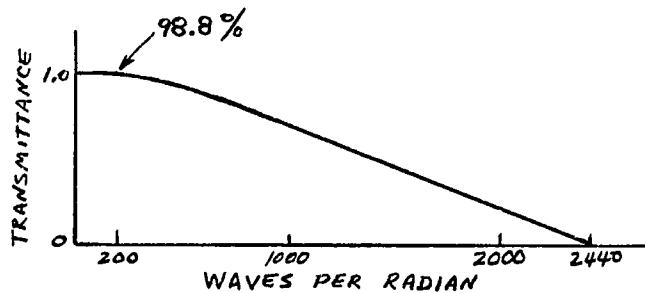


$$f(\phi) = \begin{cases} \frac{4}{\pi r} \sqrt{1 - (\frac{2\phi}{r})^2} & |\phi| < \frac{\pi}{2} \\ 0, & |\phi| > \frac{\pi}{2} \end{cases}$$

the transform of this is described as,

$$F(\omega) \approx \frac{2J_1\left(\frac{\omega\tau}{2}\right)}{\left(\frac{\omega\tau}{2}\right)}$$

This function goes to zero when  $n = 1.22$ , but the blur circle is 0.5 milliradians in diameter and at  $n = 1.22$ , the space frequency is 2440 waves per radian. A plot of the transform for the blur circle is sketched as follows:



The transmission is 98.8% at 200 waves per radian, and increases with decrease in waves per radian. In view of these considerations, no correction has been applied to the data to account for effects of the blur circle of the optical system.

The detector affects the measurements in that its response drops off with frequency. The frequency response must therefore be applied as a correction to apply in the data reduction. This was measured in a setup using a blackbody and a variable speed chopper. The resulting frequency response curve is shown in Figure 4.

The sonic analyzer has a constant bandwidth over a linear frequency scale. The scale used to record gradient meter data was from 10 to 500 cps. The resolution is defined by the manufacturer as "the frequency separation of two signals of equal amplitudes, the deflections of which intersect 0.5 down from their peak amplitude. When scanning linearly through 500 cps, signals resolve at 53 cps." The manufacturer further states that the low frequency response of the instrument is 40 cps.

The fundamental frequency generated by the gradient meter is 10 cps and any function generated is composed of frequencies separated by 10 cycles. With a resolution bandwidth of 53 cps, then 5 frequencies are present. Four of these are contributing in some respect to the amplitude of the bandpass center frequency. Additionally, the spectrum is always of the form  $\frac{1}{f}$  with a slope generally between -1 and -2.

The sonic analyzer was first carefully checked and adjusted to have a nearly flat frequency response from 10 to 500 cps. It is only possible to do this by slowing the sweep rate to one sweep per 10 seconds. This is accomplished through a triangular wave generator supplied as an accessory to the Sonic Analyzer. A

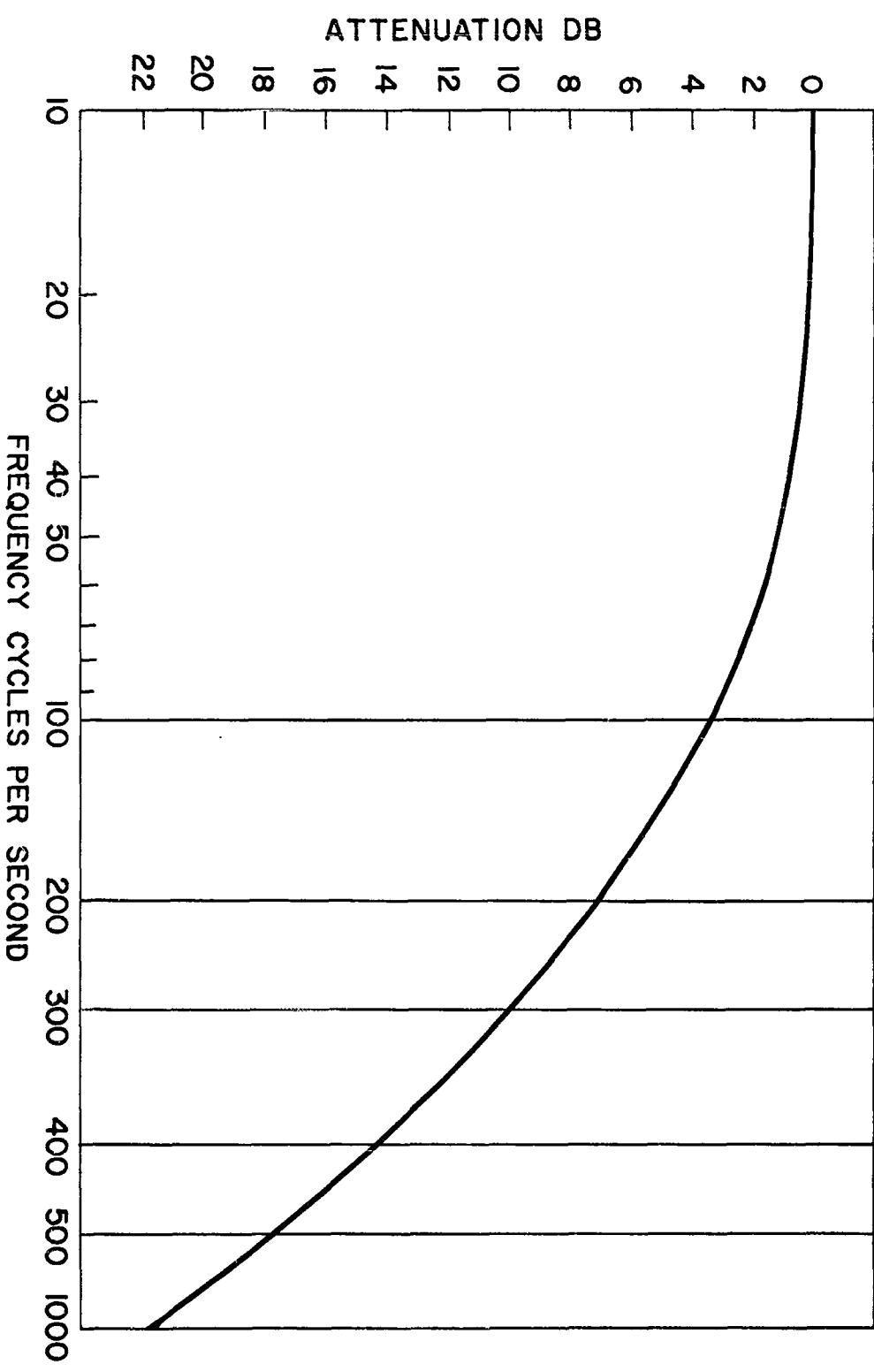


Figure 4. Frequency Response of PbS Cell - Gradient Meter.

A frequency response check shows the analyzer to be flat from 30 cps but down to 75%, or about 3 db at 10 cps. Measurements were then made upon the instrument response when presented with two signals of equal amplitude whose frequency separation was some multiple of 10 cycles. This was done in the flat frequency response area. The frequency separation was varied and the resulting response curve is shown in Figure 5. This was done in order to prove the constancy of the bandwidth. The sonic analyzer was then presented with an input of 5 frequencies with 10 cycle separation and with a slope of -1.5. The relationship between the known input and the output gives the correction factor for the center frequency. This was repeated for all center frequencies across the scale. The measurements were repeated for input slopes -1.4, -1.3, and -1.2. The results repeated very closely with the largest discrepancies being of the order of 2% around 30 cycles per second. The correction factor used in reducing the data, based on this measurement, is presented in Figure 6. The dip in this curve at about 9 waves per radian is due to the drop in frequency response of the analyzer, while the steep rise towards 3 waves per radian is due to the fact that no frequencies are present below this point. This has the effect of narrowing the bandwidth at this end of the spectrum.

To calibrate the gradient meter, it is necessary to present it with a background of known intensity gradation where the amplitude of the fundamental is known, so that an instrument sensitivity can be assigned to this fundamental. This instrument sensitivity will then be valid for all parts of the spectrum when all of the previous corrections have been applied. The low temperature blackbody was apertured to 4 inches in diameter by a mask of sufficiently large dimensions that the gradient meter would scan across either the blackbody or the mask. The gradient meter was positioned at

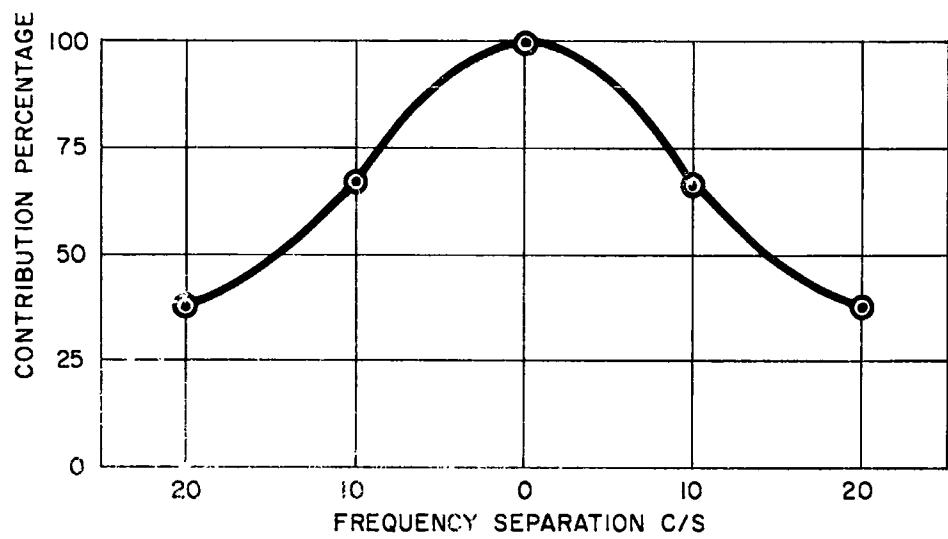


Figure 5. Resolution Bandwidth - Automatic Spectrum Analyzer.

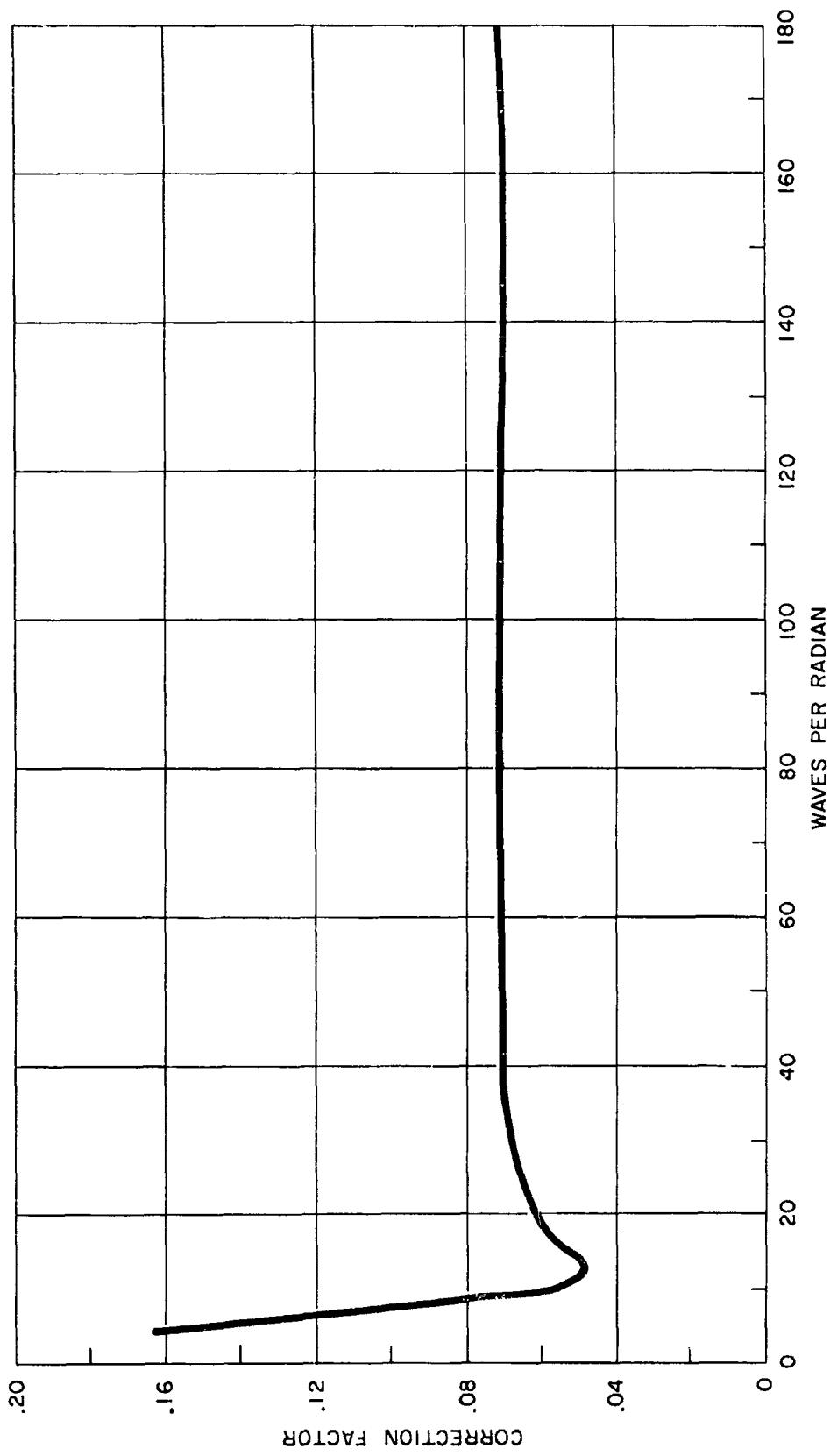
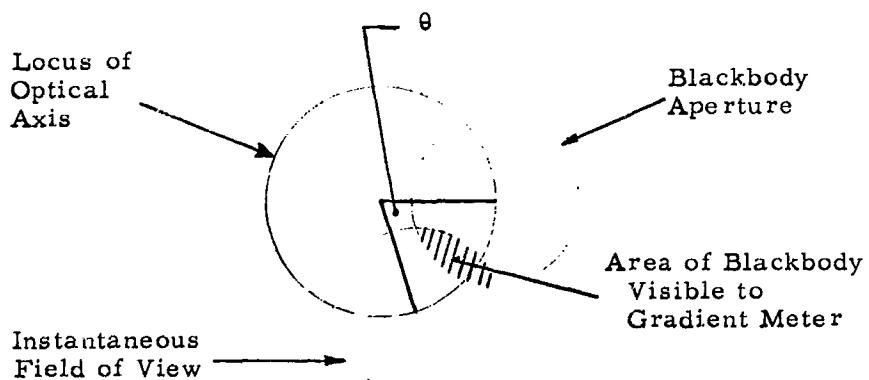


Figure 6. Correction Factor to Convert Gradient Meter Data to Unit Wave/Radian.

a distance of 4 feet and aligned so that at some point in its sweep the instantaneous object field, also 4 inches in diameter, would coincide with the blackbody aperture. With the scanning circle set at a 6 degree diameter, the optical axis will sweep a 10 inch diameter circle 4 feet from the instrument. (See Sketch) A plot of the area of the blackbody visible to the scanner versus the angular rotation,  $\theta$ , for one scan sweep is also a plot of the wave produced by the instrument due to the difference in brightness between the blackbody and the mask. Observation of this wave on an oscilloscope helps to adjust the alignment of the set-up. Analysis shows the peak amplitude of the fundamental wave to be .437 times the peak amplitude of the total wave. The amplitude of the fundamental is read on the analyzer in R. M. S. volts. The calibration was performed with the blackbody at  $100^{\circ}\text{C}$  and the mask at  $27^{\circ}\text{C}$ . In this manner, an instrument sensitivity was determined of  $5.5 \mu\text{w}/\text{cm}^2/\text{steradian/R. M. S. volt}$  for the fundamental wave, referred to the sonic analyzer input.



## GRADIENT DATA

All of the gradient data taken at Key West, Florida, has been reduced and is tabulated at the end of this report. The units used for amplitude are given as microwatts per square centimeter per steradian per unit wave per radian, for the spectral region below 3 microns. The chart is read by starting with any run number in the left hand column and reading completely across the page in a horizontal line. First is the time of day the run was taken, then azimuth and elevation of the background observed, reckoned from the instrument. The remaining columns give the radiance for several frequencies in waves/radian given as the headings of the columns at the top of the page. Also at the top of the page is given the date and the type of background. Only three classifications have been used for backgrounds. These are, (1) Blue Sky, (2) Clouds, and (3) Cloud and Sky. These simply mean that the scanning was done (1) completely on blue sky, (2) completely on cloud with no sky, and (3) on cloud edges, or across cloud and sky.

For the whole measurement period, excepting June 19th, the weather was clear with many clouds. The clouds were all cumulus, quite large and billowy and the sky was very blue, visibly. This was a condition following the break-up of a severe storm which occurred June 20th. June 19th, the day preceding the storm, was completely overcast with dark clouds and, to the naked eye, gray and quite featureless.

Parameters measured during the measuring period were ambient temperature, relative humidity, and barometric pressure. These are given in Figure 7. Of interest also is the spectral band in which the measurements were taken. The measured spectral response of the lead sulfide detector is given in Figure 8. This is

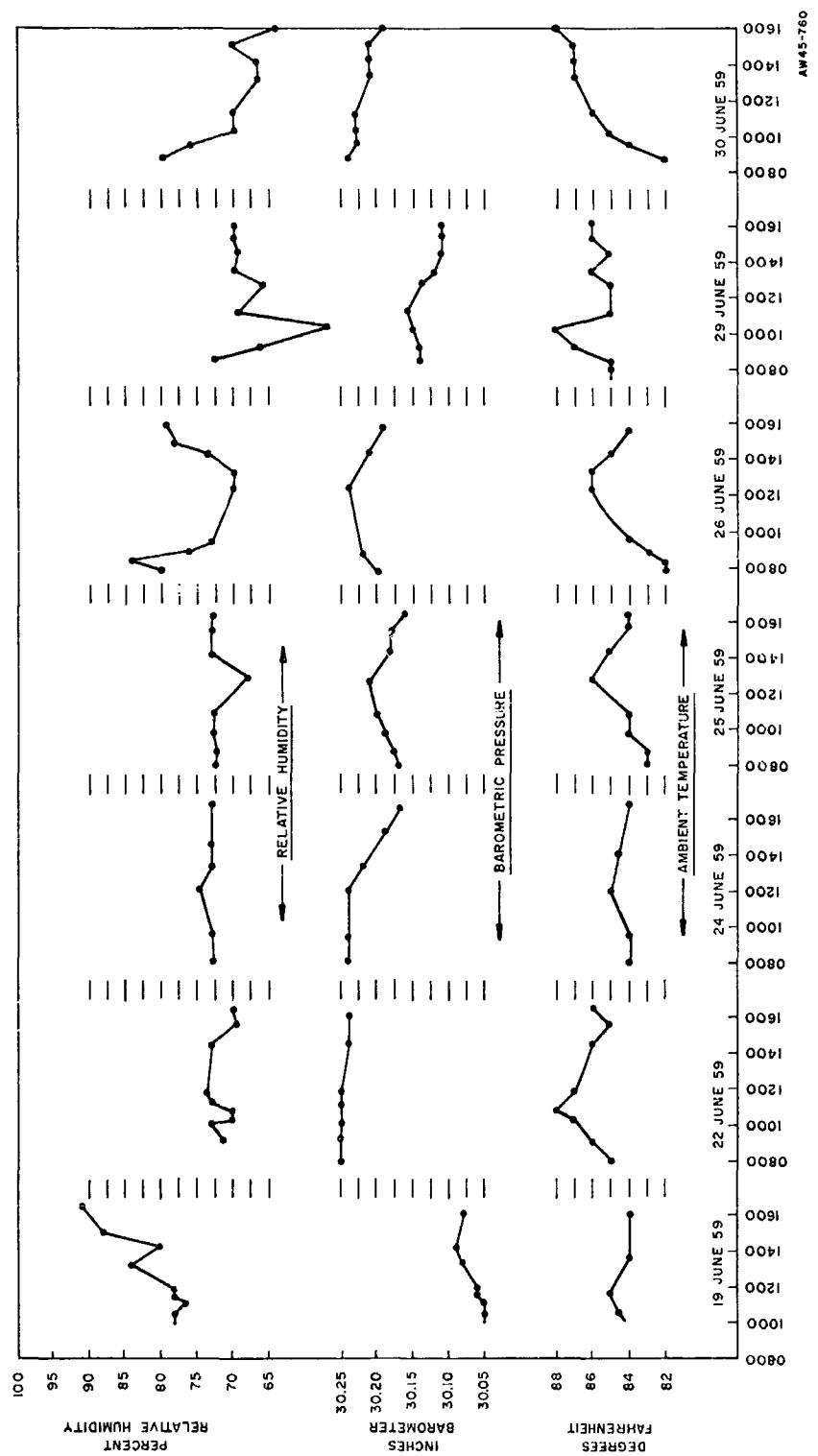


Figure 7. Ambient Temperature, Barometric Pressure, and Relative Humidity for Measurement Period.  
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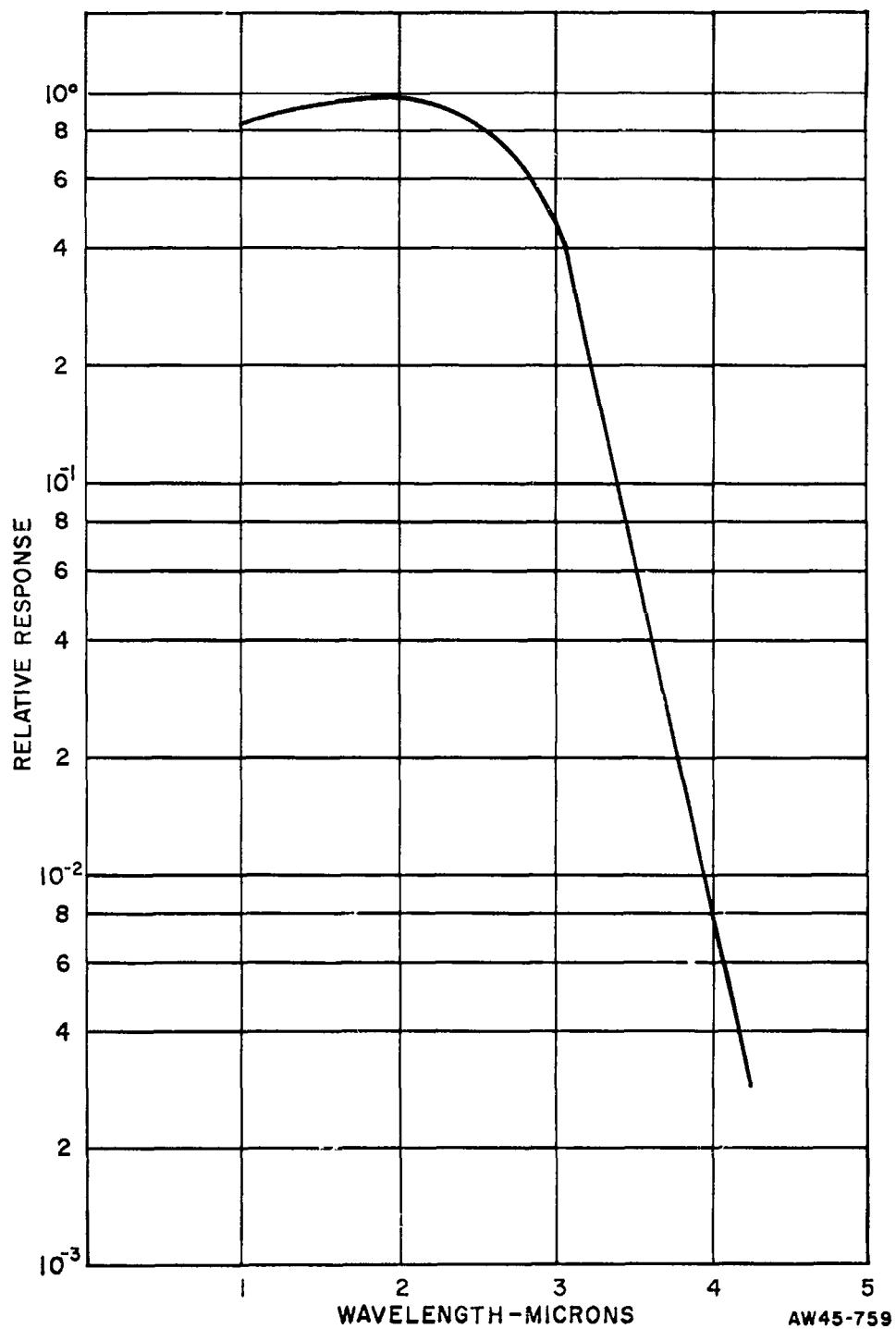


Figure 8. Spectral Response of PbS Cell - Gradient Meter.

a constant energy response curve, i.e., the response of the cell to a constant temperature blackbody has been divided by the blackbody emission curve.

The gradient meter was located in azimuth using a compass, therefore all the azimuth angles are with reference to magnetic north from Key West. The magnetic declination at Key West is  $2.5^{\circ}$  East and this must be subtracted from all azimuth readings to obtain reference to true North. Time of day given in the data charts is local standard time at Key West. Figure 9 plots the Solar altitude for the local standard time.

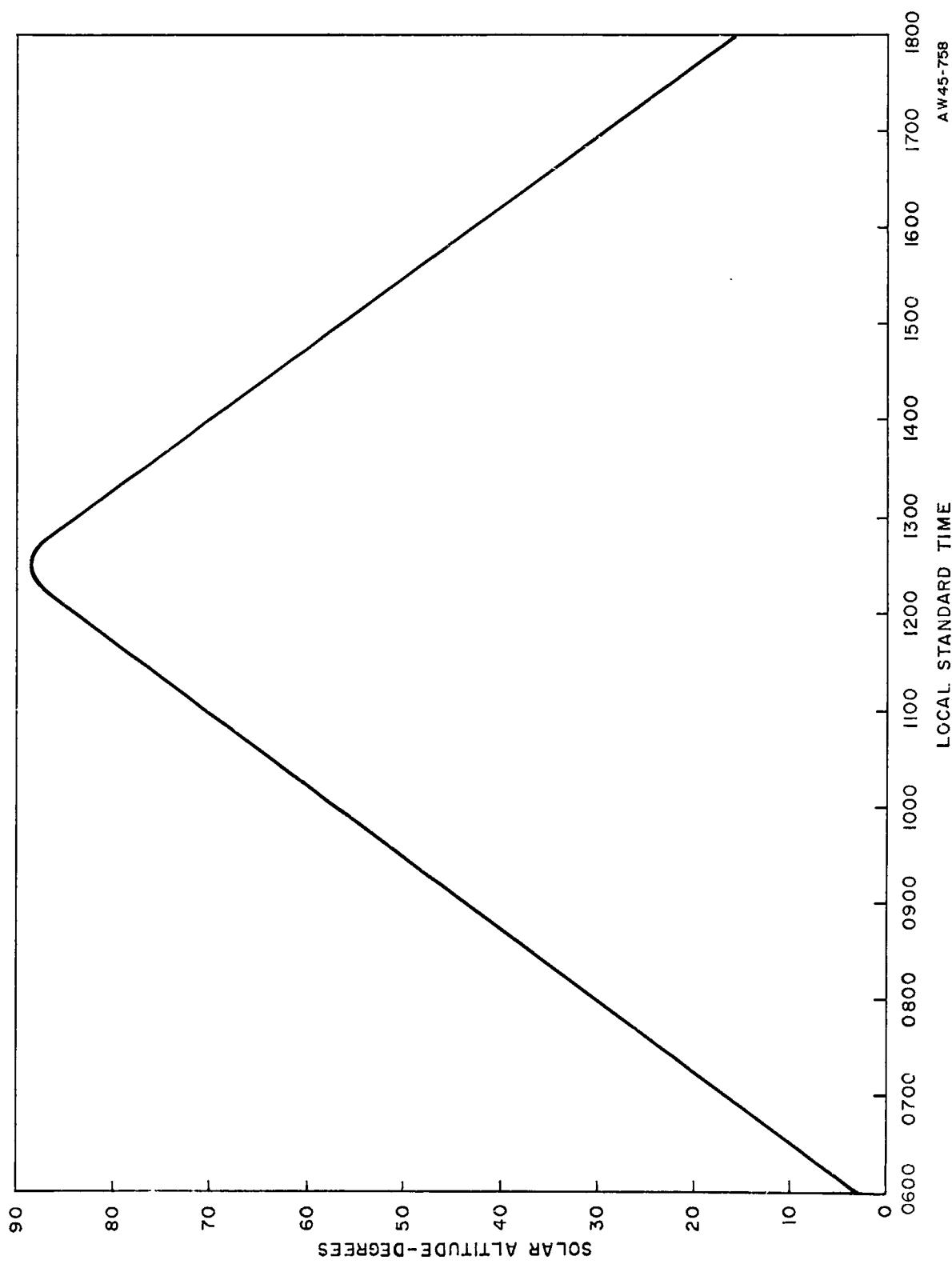


Figure 9. Solar Altitude for Key West Local Standard Time.

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19 June 1959 - Clouds

Run No.	Time	Az	El	Frequency Waves per Radian									
				3	5	7	10	20	40	60	80	100	150
				Amplitude - Microwatts . Cm <sup>-2</sup> . Ster <sup>-1</sup> . (W/R) <sup>-1</sup> - Below 3 Microns									
1	1505	270	15	4	3.5	3	2.35	1.1	.52	.126	.12	.093	.08
2	1515	270	15	3.4	2.7	2.25	1.7	.8	.28	.136	.063	.043	.023
3	1520	15	17	10	7	5.3	3.9	2	1.36	.6	.42	.3	--
5	1540	0	5	7.5	4.2	2.9	2	1.03	.42	.12	.06	.044	--
6	1544	0	10	10	5.8	4	2.65	1.2	.52	.46	.25	.21	.11
7	1547	0	15	6.9	6.9	6.5	5.6	5.6	2.4	.42	.62	.22	.01
8	1548	0	20	11.7	11.8	9.6	6.1	1.6	.63	.19	.13	.082	.014
9	1549	0	25	6.6	8.6	8.7	7.4	3.2	1.3	.88	.62	.54	.3
10	1550	0	30	7.8	5.8	4.7	3.5	1.75	1.15	.87	.44	.53	.17
11	1553	0	35	11.5	10.5	9.3	7.5	3.2	1	.42	.45	.29	.15
12	1600	0	50	11.7	10.5	8.5	5.8	1.7	.55	.42	.13	.145	--
13	1625	0	80	16	13	10	6	1.4	.58	.28	--	--	--
14	1630	0	80	10.5	10.5	8.3	5	1.5	.57	.175	.105	.095	.12
15	1631	0	85	11.5	12.5	10.5	6.7	1.65	.56	.22	--	--	--
16	1632	0	85	11.5	11.4	8.8	5	1.05	.38	.15	.15	.13	.072
17	1637	0	90	11.5	10	7.8	5	1.4	.42	--	--	--	--
18	1643	330	19	11.2	11.6	9.7	6.3	1.8	.67	.36	.26	.15	.05
19	1645	330	19	11.3	10	7.5	4.8	1.15	.36	.24	.135	.105	.1
22	1705	151	28.5	33	28.5	24	19.5	11.5	5.8	2	2.6	2.1	.12

## 22 June 1959 - Blue Sky

## Frequency - Waves per Radian

Run No.	Time	Az	E1	3	5	7	10	20	40	60	80	100	150
3	0917	180	15	17.5	23	21	12.3	7.4	4.3	2.2	1.07	1.2	.54
14	1003	90	45	45	43	39	33	27	7.6	10.7	7	4.6	2.25
15	1016	180	45	2.75	3.05	2.6	1.1	.4	.032	.05	--	--	--
16	1018	270	45	15	9	6	3.6	1.2	.56	.46	.23	.164	.053
18	1023	0	60	7.5	8.5	7.8	5.8	1.15	.32	.16	.103	.056	.055
21	1032	180	60	4.3	4.2	3.3	1.9	.39	.13	.029	.018	.013	.011
22	1034	270	60	2.7	2.3	1.85	1.2	.31	.054	.019	.02	--	--
37	1114	330	55	4	4.3	3.8	2.75	.84	.195	.1	.038	.021	--
38	1128	290	65	8.6	8.5	6.7	4.3	.93	.195	.075	.042	.024	.042
39	1129	40	40	16	9.5	6.5	4	.135	.12	.026	.017	.029	.015
40	1131	150	40	3.6	4	3.4	2.1	.4	.14	.026	.017	.017	.0032
42	1134	240	40	6.8	3.2	2.1	1.4	.52	.175	.074	.157	.018	--
69	1509	180	5	11.7	11.3	8.8	5.1	1.4	.47	.27	.37	.25	.115
70	1513	180	5	7.2	6.6	4.9	2.8	.62	.031	--	--	--	--
71	1516	180	40	4.8	4.8	3.8	2.15	.34	.09	.052	--	--	--
72	1520	180	60	5.1	6	4.9	2.8	.33	.155	.0125	--	--	--
73	1532	180	80	6.1	6.2	5.1	3.4	.82	.225	.067	.062	.032	.0085
74	1533	180	90	6.4	8	7	4.4	1.35	.21	.12	.087	.063	--
75	1556	90	5	7.1	6	5.1	4	1.9	.9	.53	.2	.16	--
76	1559	90	20	6.4	6	5.2	3.7	1.13	.42	.2	.29	.105	--

22 June 1959 - Blue S.Y.  
Frequency - Waves per Radian

Run No.	Time	Az	E1	3	5	7	10	20	40	60	80	100	150
77	1601	90	40	4.3	3	2.5	1.55	.6	.35	.34	.16	.039	--
78	1603	90	60	2.6	1.65	1.23	.9	.42	.112	.07	.032	.028	--
79	1605	90	80	2.5	1.7	1.25	.85	.33	.15	.07	.054	.034	--
80	1607	90	1.9	1.72	1.4	1	.34	.13	.097	--	--	--	--
22 June 1959 - Clouds													
1	0913	0	15	43	56	60	54	26	8.5	9	5.2	3.6	.86
4	0922	270	15	245	150	100	60	20.2	19	12	9	5.8	1.9
7	0933	180	25	163	76	45	25	10.5	4.8	2.7	3	1.75	.074
8	0935	270	25	135	110	85	58	18	8.8	2.63	1.65	2	--
9	0943	0	30	235	135	87	51	19.5	11.3	6.7	3.6	1.8	--
19	1028	90	60	860	1000	950	600	135	44	23	7.7	4.9	5.1
43	1148	13	20	40	34	27.5	20.5	11.7	8	4	2.5	1.57	.63
44	1151	300	20	52	48	41	33	22.5	10.5	4.7	2.9	2.2	1.9
45	1153	175	20	66	60	42	24	11	9.5	3.6	1.7	2.65	1.35
46	1154	20	23	43	31	22.5	16	12	3.7	4.3	2.2	2.2	.95
47	1157	0	60	190	112	73	48	20	12	9	7.5	6.5	4.8
48	1159	35	20	98	60	42	30	14	5.2	2.65	1.6	.8	.6
49	1200	80	5	48	44	36	26.5	18.6	18.6	7.7	2.7	3.6	3
50	1316	122	10	19	28	26	20	9.2	7.5	3.1	2.4	1.6	.8
51	1319	40	10	25.5	35	36	21	13	9	6.4	2.6	2.5	1.1
52	1322	40	10	22.5	26.5	25	20	7.6	3.9	5.6	2.6	1.1	.82
53	1326	312	10	32	46	53	48	16.3	19	8	6.2	2.5	1
54	1328	29	10	100	55	39	29	20	17	6.2	6.2	5.8	3.1
55	1335	337	17	35	12	8.8	7	4.6	3	1.8	.63	.46	.51

22 June 1959 - Clouds

Run No.	Time	Az	E1	Frequency - Waves per Radian							
				3	5	7	10	20	40	60	80
56	1349	305	17	53	70	67	49	17	14	4.4	3.6
57	1358	220	31	177	90	56	32	11.2	5.2	3.4	2.1
58	1404	36	17	34.5	29	22	14.6	5.4	4.6	1.2	1
59	1410	310	17	53	49	46	41	35	14.7	9.8	7.6
61	1433	43	10	38	43	39	30	13.5	9.2	4.6	2.7
64	1445	119	7	22.5	25	22	17	10	3.8	1.7	1.4
67	1458	44	41	37	44	35	19	7.8	4.3	2.5	1.6
68	1502	346	22	145	68	42	26.5	11.5	7.2	4.7	2.4

22 June 1959 - Cloud and Sky

Run No.	Time	Az	E1	Frequency - Waves per Radian							
				3	5	7	10	20	40	60	80
2	0915	90	15	140	102	73	46	28	17.5	19	19
5	0927	0	25	242	270	180	73	29	19.5	13	9
6	0930	90	25	350	270	200	135	48	31	14.5	11.6
10	0945	90	30	17.8	20	16.5	8.5	2.2	1.75	.52	.28
11	0947	180	30	50	44	37	28	15	7.7	3.6	1.6
12	0950	270	30	63	59	48	26	10	3.2	1.43	.95
13	1000	0	45	115	60	42	28	10.5	4.2	2	2.3
17	1022	0	60	175	110	75	46	21	13	8.8	7.5
23	1037	0	90	110	90	58	32	15	10.4	8.8	5.4
25	1041	0	15	157	116	82	49	20	8.3	4.6	3.3
27	1053	15	27	185	95	60	42	44	11	11.6	6.4
36	1112	0	15	53	42	34	25	10	6.9	4.2	2.35
60	1428	200	10	103	60	45	35	24	13.7	7.5	7.3
62	1437	65	6	23	25	23.5	20.5	14.5	7.6	6	2.9
63	1442	344	17	135	68	43	25.5	9.3	7	3.8	1.42

22 June 1959 - Cloud and Sky

Run No.	Time	Az	El	Frequency - Waves per Radian									
				3	5	7	10	20	40	60	80	100	150
65	1449	297	10	110	92	65	44	29	23.5	15	13.5	10	6.3
66	1452	94	51	175	100	65	42	17	8.3	3.4	2.05	1.85	--
81	1618	0	5	6	5.8	5.3	4.4	3	1.2	1.65	.55	.65	.125
82	1622	0	20	6.2	4.8	4	3.1	2.75	2.2	1.13	.57	.75	.62
83	1626	0	40	3.5	3.6	2.8	1.27	.58	.24	.077	.062	.018	-
84	1629	0	60	5.8	3	1.9	1.25	.55	.36	.13	.08	.07	.048
85	1633	0	80	4.3	2.4	1.75	1.25	.8	.4	.1	.115	.125	.012
86	1635	0	90	3.9	3.4	2.65	1.7	.57	.23	.13	.087	.08	.6311
88	1645	20	270	135	75	46	26.5	8.5	8	5.8	3.2	1.7	--
89	1652	40	270	149	71	42	22	6	2.4	2.8	1.3	1.6	--
91	1700	90	270	70	54	42	29	10.5	4.4	3.2	1.7	1.3	--

24 June 1959 - Blue Sky

Run No.	Time	Az	El	Frequency - Waves per Radian									
				3	5	7	10	20	40	60	80	100	150
23	1144	110	40	4.3	4.4	3.9	2.9	1	.25	.095	.073	.061	--
24	1147	110	60	6.4	6.8	6.1	4.5	1.33	.213	.077	.065	.084	--
29	1208	190	80	48	45	36	24	6.2	1.25	.49	.47	.32	.215
24 June 1959 - Clouds													
8	1007	22	21	68	26	17	14.2	12.5	6.4	3.5	4.9	3.3	4.5
21	1137	110	5	40	40	38	33	18	12	10	4.8	5.6	3.5
27	1202	190	40	53	69	68	52	14	9.5	4.6	2.4	1.7	2.2
28	1212	190	60	150	85	58	38	23	11.8	4.8	6.4	6.8	2.1
30	1317	180	5	190	185	170	135	9.5	8.2	4.8	5.8	3.7	--
31	1319	160	5	21	16	14	12	11	4.7	4.8	2.2	2.65	1.6
32	1324	120	6	37	46	48	43	18	10.5	7	9	7.3	3.7
33	1327	97	8	80	56	50	42	24	12.5	8.8	4.9	2.8	2.2
34	1332	50	6	31	40	42	40	25	10.5	9.3	6.2	6.8	2.1
35	1335	25	5	29	31	30	27	22	14.5	5.8	5.8	4.9	2.6
36	1339	342	8	42	39	36	31	18	10.5	11.5	4.1	4.3	--
37	1432	280	12	50	53	54	52	38	21	16	7.7	12	8
38	1439	320	18	135	100	83	62	26	16	11	6.5	6.3	4
39	1442	280	18	190	128	90	59	24	15.5	11.4	6.5	3.9	1.25
40	1447	46	18	67	49	44	37	20.5	9	6.8	3.2	2.25	1.85
41	1451	30	6	137	103	70	44	19	16	9.5	4.4	4.4	3.2
42	1455	100	6	39	42	43	43	43	18.5	12	9	5.5	3.3
43	1502	159	9	120	68	42	27.5	19.5	11.5	5.4	3	2.4	1.15
44	1505	190	9	150	96	58	47	23	13.5	11	5.2	3.8	3
45	1508	210	9	200	140	115	85	36	14	15	7.8	7.4	6

24 June 1959 - Clouds

Run No.	Time	Az	El	Frequency - Waves per Radian											
				3	5	7	10	20	40	60	80	100	150		
46	1518	95	9	57	72	70	55	22	14.5	9.7	7.8	4.8	3.9		
47	1522	40	9	31	33	30	23.5	15	7.8	3.1	3.2	2	1.2		
48	1523	350	9	125	82	55	40	23.5	17	11.5	8.3	6	3.9		
49	1536	280	17	43	55	57	54	37	13	18	7.3	6.7	4.8		
50	1539	300	7	82	36	30	28	27	28.5	11	10.5	6.5	3.4		
51	1542	345	7	86	75	63	49	29	21.5	9.8	5.9	4.3	3.1		
52	1547	12	7	87	85	73	52	21	12.5	8	7.1	7.7	6.4		
53	1549	51	7	44	34	29.5	25.5	22	9.6	6	3.7	1.9	1.03		
60	1625	285	4	75	62	52	41	22	80	13	20.5	10	15.5		
61	1628	295	13	130	148	112	72	25.5	15.5	13	11	10.5	7		
62	1639	327	4	38	45	50	52	43	18.5	15	13	15	6.5		
63	1642	355	4	41	52	50	40	18	9.6	5.4	4.3	3.5	3.2		
64	1644	15	3	15	20	18	11	18	10.5	4.4	7.3	4	--		
65	1647	350	8	90	69	54	39	19	10	6.2	5	3.6	1.13		
66	1650	23	8	88	89	75	54	20	15	6.2	3.8	2.65	1.25		

24 June 1959 - Cloud and Sky

1	0935	298	2	107	95	76	53	18.5	11.5	5.1	4.1	5.4	5.2		
2	0939	340	2	49	35	26.5	20	15	12	5.2	5.1	3.3	1.7		
3	0943	0	5	26	26	20.5	13	15.5	7	4.6	2.2	1.85	--		
4	0950	17	5	50	67	65	48	18	11.5	10.5	6.5	3.8	2.65		
18	1124	270	60	5.6	5	4.3	3.7	5.1	2.2	.98	.44	.215	--		
25	1150	110	80	50	60	61	53	37	18	16.5	12	13	11		

25 June 1959 - Blue Sky

Run No.	Time	Az	EL	Frequency - Waves per Radian								150	
				3	5	7	10	20	40	60	80		100
1	0852	190	10	11	10.8	8	4.4	.95	.42	.135	.062	.026	..
2	0854	190	20	6.8	5.6	4.1	2.5	.95	.33	.15	.088	.072	..
3	0903	190	40	2.8	2.5	1.9	1.1	.24	.075	.0245	.051	.048	.042
4	0908	190	60	2.4	2.4	1.7	.97	.15	.042	.029	.0175	.016	..
5	0910	190	80	2.8	2.9	2.25	1.2	.21	.056	.038	.0115	.0096	..
6	0914	90	3.7	3.2	2.35	1.35	.3	.036	.0235	.014	..	..	..
7	0917	100	5	48	37	30	22.5	11.5	5.2	3.1	4.6	3.6	1.4
8	0920	100	20	10.5	8	6.7	5.5	5.2	1.35	3	2.6	3	..
9	0922	100	40	19	16	11	6.8	2.05	1	.75	.225	.095	..
10	0934	100	60	32	34	29	19	5.	1.25	.54	.38	.28	.12
11	0937	100	80	14.5	16	13.5	8.8	1.9	.44	.19	.15	.1	.054
12	0939	90	8.6	10.3	9	5.8	1	.23	.125	.08	..	..	..
13	0942	0	5	76	54	42	30	14.5	11	3.4	4.6	3	1.55
14	0946	330	20	6.7	7	5.6	3.2	.5	.185	.091	.057	.019	..
15	0949	0	40	7.1	7	5.7	3.6	.86	.21	.115	.08	.064	..
16	0953	0	60	6.2	6.8	5.6	3.4	.6	.15	.08	.1	.07	..
17	1004	0	80	11.3	15	12	7.2	1.7	.42	.26	.15	.12	.097
18	1006	0	90	15	17	14.5	9.2	1.65	.45	.25	.17	.14	.12

Run No.	Time	Az	EL	Frequency - Waves per Radian								150	
				3	5	7	10	20	40	60	80		100
21	1015	355	3	29	34	34	30	24.5	18.5	9.5	6.7	6.3	4.3
22	1019	21	6	77	60	48	36	27	9.7	11	7	3.4	1.7
23	1023	33	6	39	52	52	42	22	23.5	15.5	6	4.9	3.2
24	1027	30	15	185	80	56	42	23	10.7	5.6	4.7	3	2.8
25	1058	102	6	72	60	45	31	25.5	19	10	6	4.7	4.3

25 June 1959 - Clouds

25 June 1959 - Clouds  
Frequency - Waves per Radian

Run No.	Time	Az	EI	3	5	7	10	20	40	60	80	100	150
30	1102	120	8	58	54	46	37	22	18	12.5	6.6	5.3	5.7
31	1119	115	19	62	51	45	37	36	12	5.4	4.4	3.2	2.4
32	1123	140	9	136	92	62	34	19	14	10.5	3.8	3.2	3.4
33	1129	145	9	47	47	38	28.5	17	16	7.5	3	4.8	2.8
34	1132	168	6	39	46	42	34	14.3	12.3	9.5	3.6	2	2.15
35	1135	279	25	142	78	55	40	21.5	12.5	8.3	8	7.7	6.8
36	1138	287	13	113	128	85	50	27	20	7.2	4.1	3.4	2.65
37	1142	297	17	195	98	66	45	22	12	6.6	5	3.2	2.2
38	1145	317	24	163	100	70	46	20	11.3	8	6	5.4	4.2
39	1147	308	36	175	78	56	43	23	12	8	7.4	7.2	6
40	1152	335	27	165	95	65	41	29	11	7.5	7.4	7.5	7
44	1302	202	5	27	30	27	23	26	15.5	12.5	8.6	3	2.5
52	1351	130	11	53	61	58	48	24.5	8.5	7.5	3	3.2	1.7
55	1403	315	7	54	58	54	48	31	15	13	9	5.5	--
57	1423	110	22	46	62	63	56	24	8.3	3.3	1.45	.95	1.05
58	1427	60	12	150	83	58	40	20	12	8.8	5.7	4.1	1.6
59	1429	12	10	49	52	48	41	32	23	10	7.7	4.8	1.6
65	1458	320	11	170	121	85	54	25	13	6	5.6	3.1	1.45
66	1501	310	5	62	44	36	29	27	16	8.2	4.5	3.6	2.3
67	1505	285	5	88	78	58	40	29	18	19	8.9	8.3	6.2
68	1508	305	5	113	78	62	48	25	19	13.5	9.8	7.3	3.5
69	1529	300	8	60	75	65	48	25	22	10	4.5	8.5	5
70	1534	322	8	163	75	52	38	20.5	8.2	4.8	3.2	2.9	.77
71	1538	340	8	148	95	65	43	19	8.9	8.4	1.9	2.2	--
72	1545	330	8	145	17	7.2	4.2	1.7	1.3	.57	.49	.29	.195



26 June 1959 - Blue Sky

Run No.	Time	Az	El	Frequency - Waves per Radian									
				3	5	7	10	20	40	60	80	100	150
				Amplitude - Microwatts . Cm <sup>-2</sup> . Ster <sup>-1</sup> . (W/R) <sup>-1</sup> - Below 3 Microns									
9	0838	250	37	4.9	3.1	2.1	1.4	.6	.25	.20	.084	.08	.05
17	0910	0	10	1.3	10.1	7.9	4.8	.89	.33	.19	.13	.12	.07
18	0912	0	20	8.8	8.2	6.6	4.4	1.0	.19	.098	.031	.024	.01
19	0914	0	40	4.9	4.0	3.9	2.7	.40	.155	.52	.49	.015	--
20	0916	0	60	5.1	4.6	4.1	3.4	.52	.21	.062	--	--	--
21	0919	0	80	9.0	7.2	5.2	3.5	.46	.19	.07	.054	.035	.011
22	0921	-	90	12	9.2	7.9	4.6	.72	.23	.13	.082	.05	.025
23	0923	180	80	3.7	3.7	3.0	1.6	.49	.086	.014	--	--	--
24	0925	180	60	2.5	1.8	1.35	.86	.23	.052	--	--	--	--
25	0928	180	40	2.9	2.65	2.0	1.15	.26	.06	.018	--	--	--
26	0930	180	20	6.9	6.1	4.4	2.4	.42	.14	.06	.03	.017	--
				Clouds									
1	0754	125	10	31	23	17	11.5	4.3	1.7	.80	.62	.42	.10
2	0800	130	19	89	88	76	56	23	15	12.5	6.5	4.7	3.4
4	0805	105	18	185	89	56	38	18.5	9.6	4.6	4.4	3.8	1.1
6	0810	86	7	165	135	100	64	24	13	6.8	4.2	2.0	1.4
7	0812	120	7	50	46	38	26	16	12.5	15	7.9	7.0	2.2
8	0815	64	12	210	140	94	60	21	7.9	9.5	4.6	2.4	2.1
10	0842	292	25	112	102	72	31	13	8.0	4.1	5.3	2.0	.72
12	0847	305	11	89	85	80	50	5.0	.76	.41	.24	.26	.15
14	0852	315	4	44	33	33	25	9.5	6.2	3.9	1.8	1.07	.14

26 June 1959 - Clouds  
Frequency - Waves per Radian

Run No.	Time	Az	EI	3	5	7	10	20	40	60	80	100	150
15	0854	315	11	104	75	50	32	15	6.0	6.8	2.8	3.3	1.4
16	0857	333	4	30	26	24	21	12	5.2	6.0	3.0	3.2	1.4
38	1026	20	10	155	120	78	43	24	7.4	4.1	4.1	2.1	.93
40	1101	150	25	155	120	82	48	15	11	5.2	4.2	3.4	1.6
41	1103	188	16	24	18	14.5	11	4.6	2.1	1.3	.63	.39	.19
42	1107	170	5	48	45	39	31	15.5	12.5	10.5	5.1	4.9	1.6
43	1110	165	10	38	33	30	26	22	23	12.5	7.2	7.8	2.6
45	1114	160	10	58	56	46	37	23	10.5	5.6	4.9	3.5	2.2
52	1233	342	5	44	37	36	32	28	11.8	7.9	8.1	3.6	2.7
56	1313	330	4	27	23.5	22	20.5	17	10.4	6.0	2.8	1.9	.75
57	1315	5	7	27	23	21.5	21.5	18.5	13.5	5.9	4.7	3.3	1.5
58	1319	337	21	115.5	105	72	40.9	17.5	8.9	5.5	4.4	3.2	.78
59	1322	347	21	113	48	34	28	22	10	4.6	4.8	3.9	3.2
60	1325	3	22	118	102	70	48	24	16	14.5	8.7	10.8	3.6
61	1327	40	8	215	66	43	32	22	20	8.0	3.7	2.5	2.4
62	1338	53	35	310	285	218	115	29	19	13.5	8.6	6.0	3.7
63	1344	103	5	39	38	32	24	11.5	9.0	6.5	8.0	6.0	3.3
64	1347	118	26	125	78	48	25	7.5	4.1	1.5	1.0	.74	.28
70	1404	344	37	180	120	75	46	18	11.4	6.8	7.5	6.4	1.8
89	1518	147	6	175	92	72	38	16.2	15	5.0	4.3	3.7	1.6
90	1520	149	9	118	61	46	37	28	14	7.7	4.0	3.8	3.1

## 26 June 1959 - Cloud and Sky

Run No.	Time	$\Delta x$	E!	Frequency - Wave per Radian									
				3	5	7	10	20	40	60	80	100	150
3	0803	130	10	118	82	61	41	14.5	5.2	3.0	2.75	1.13	.59
5	0808	65	18	150	105	79	57	34	27	9.0	11.0	9.8	2.1
11	0845	300	25	200	130	85	54	25	15	9.2	5.5	3.6	1.45
13	0849	305	10	170	125	91	62	25.5	24	9.8	8.3	7.4	1.35
27	0932	180	10	140	105	74	43	20	8.5	7.9	3.5	2.7	.85
28	0935	134	13	16.5	10.9	7.2	5.2	3.0	4.2	3.1	1.7	2.1	1.4
29	0937	168	15	21.5	20	21.5	20.05	18.5	13	8.5	5.6	3.9	1.2
30	0939	156	12	14.5	11	8	5	2.7	5.4	3	1.7	2.3	.72
31	1002	120	26	8	6.4	5.4	4.7	4.1	3.7	2.6	1.35	1.0	.7
32	1003	125	11	17	13	10	7	3.9	3.4	3.1	2.0	1.49	.58
33	1011	117	12	22	14.9	9.4	5.4	2.1	1.49	.8	.6	.54	.1
34	1015	90	22	180	110	86	68	36	20.5	17.5	12	8	9.2
35	1017	87	15	295	360	310	170	82	51	26	15	18	7.2
36	1021	83	6	185	130	92	57	22	16	13	8.7	7.4	3.0
37	1023	58	15	155	97	71	53	35	23.5	10.9	13.8	7.7	6.4
39	1028	10	4	47	50	46	36	17	16	8.8	4.7	3.9	1.5
44	1112	192	10	32	28.5	25	21.5	14.5	7.5	4.6	2.6	1.9	.7
46	1116	100	13	26	20.5	18	16.5	15.5	11.9	9	3.9	1.9	.54
47	1118	143	13	140	78	50	33	20	15	5.8	5	3.6	1.7
48	1129	16	13	140	108	79	50	16.5	12	7.6	5	4.9	2.85
49	1132	120	13	175	86	53	30	11.6	9.8	6.	4.2	2.9	1.2
50	1134	86	13	133	83	54	36	25	12.5	7.9	6.5	5.9	4.3
51	1129	345	3	28.5	36	38	35	20	11.3	4.8	4.9	3.8	1.8

## 26 June 1959 - Cloud and Sky

Run No.	Time	Az	El	Frequency - Waves per Radian											
				3	5	7	10	20	40	60	80	100	150		
53	1236	310	12	155	118	83	59	28	12.5	7.3	6	4.2	1.6		
54	1238	318	7	135	170	150	75	18	15.2	11.2	9.9	8	4.7		
55	1241	340	5	27.5	22	17	11.5	4.7	3.9	2.2	2.05	1.55	1		
65	1351	157	10	51	55	47	34	27.5	11.9	4.6	3.3	2.1	.89		
66	1354	134	10	155	85	50	26.5	8.8	9.1	4.2	2.7	2.3	1.1		
67	1357	275	25	195	115	76	51	25.5	13.5	8	7	6.8	5.2		
68	1359	255	25	200	110	78	56	31.5	15	6	5.8	5.1	3.05		
69	1401	315	11	125	108	85	57	26	13.3	7.5	4.8	5	3.3		
71	1406	327	8	103	68	47	34	22.5	15	13.5	7.3	5.5	3.3		
72	1419	46	8	64	60	54	44	27.5	13.5	5.2	2.85	2.65	.6		
73	1423	17	8	51	50	44	36	21.5	13.5	5.7	5.1	3.5	1.85		
74	1426	320	8	44	57	60	54	23.3	17.3	8	3.5	5.3	3.3		
75	1428	48	5	22.5	25	22	17.5	12.5	13	5.6	1.9	4.2	1.55		
76	1430	26	5	11.3	10.5	8.7	6.8	4.3	5.	3.3	1.83	1.85	.78		
77	1432	7	5	35	25	17	11.5	8.2	5.	2.8	2.05	1.45	.65		
78	1433	10	5	39	40	28.5	18	7.5	5.6	2.8	3.4	3.2	1.22		
79	1435	51	5	20.5	21.5	19	15.6	10	5	5.5	1.67	2.06	1.25		
80	1448	50	5	98	110	75	44	24	11.5	4.8	2.4	1.85	1.55		
81	1451	15	5	76	73	62	45	17.5	19	6	5	3.4	2.7		
82	1454	344	5	21	16	15	14	9.7	5.6	2.75	1.7	1.25	.59		
83	1456	198	6	19.5	16	13.5	11.5	8.8	6	5.7	2.8	2.1	1.6		
84	1459	193	6	50	63	59	41	16	16.2	5.5	7.6	3.3	2.8		
85	1501	175	6	27.5	25.5	21	15.5	6.5	2.6	4	3.1	2.9	1.45		
86	1503	180	6	23.5	19.5	17.5	15	11	3.55	3.4	2.8	1.3	1.5		
87	1506	148	6	42	30	25	21	24	14	7.7	4.3	4.5	2.3		
91	1522	152	16	172	110	180	52	22	11.5	3.4	4.2	3.4	2.4		

29 June 1959 - Clouds

## 29 June 1959 - Blue Sky

Run No.	Time	Az	E1	Frequency - Waves per Radian								150	
				3	5	7	10	20	40	60	80		
35	1039	0	60	19	18.5	14.7	8.2	1.4	.49	.20	.12	.11	.064
36	1042	0	80	35	25.8	18.3	11.4	3.22	.81	.33	.23	.13	.042
37	1044	0	90	36	25.8	18.7	11.6	3.05	.80	.37	.28	.22	.16
38	1050	180	80	26	15.5	10.2	6.0	1.8	.56	.29	.18	.15	.12
39	1052	180	60	5.5	4.5	3.2	2.0	.48	.088	.025	.01	--	--
40	1053	180	40	4.5	4.4	4.3	1.7	.44	.172	.099	.048	.04	.019
72	1421	180	10	13.5	10.6	8.8	6.6	3.3	1.75	.95	.28	.21	.069
73	1426	180	20	7.2	6.7	5.6	3.3	.68	.29	.165	.091	.093	.076
74	1428	180	40	7.5	7.3	6.8	4.1	.37	.016	--	--	--	--
75	1430	180	60	11.8	11.1	6.6	4.6	.83	.28	.16	.034	.011	--
76	1432	180	80	18	11.8	8.1	5.2	1.6	.4	.10	.01	--	--
77	1436	-	90	18.8	17.5	17	10.4	1.4	.4	.086	.01	--	--
78	1438	0	80	15.6	14.5	10.7	5.6	.94	.32	.18	.12	.095	.081
79	1441	0	60	5.6	5.3	4.1	2.3	.46	.054	.015	--	--	--
80	1443	0	40	2.6	2.4	1.9	1.24	.25	.051	.032	.011	--	--
81	1445	0	20	7.0	5.9	4.7	3.3	1.2	.32	.13	.083	.057	.032
86	1509	90	20	7.6	4.4	2.9	1.6	.41	.11	.055	.026	.017	--
87	1512	90	40	3.5	3.1	2.1	1.02	.24	.016	--	--	--	--
88	1515	90	60	2.3	1.7	1.25	.82	.19	.032	.01	--	--	--
89	1517	90	80	2.5	2.2	1.7	1.1	.29	.048	.029	.016	.011	--
90	1518	-	90	5.3	4.1	2.9	1.82	.5	.072	.013	--	--	--
91	1520	270	80	14	13.6	11.4	7.4	1.78	.25	.036	--	--	--
92	1523	270	60	17.2	9.0	5.4	2.8	.7	.2	.15	.076	.052	.038
93	1526	270	40	17	9.2	5.4	2.90	.67	.18	.09	.058	.045	.035
94	1529	270	20	20	12.6	8.9	5.6	1.85	.65	.33	.19	.16	.1

29 June 1959 - Blue Sky  
Frequency - Waves per Radian

Run No.	Time	Az	E1	3	5	7	10	20	40	60	80	100	150	
29 June 1959 - Cloud and Sky														
95	1532	270	5	28	17.5	11.1	6.8	2.5	.83	.37	.22	.18	.14	
4	0858	110	40	145	107	70	37	22	16.7	8.6	6.5	4.8	3.6	
7	0910	98	31	155	115	90	66	40.7	31	17.8	16.3	12.8	6.7	
11	0917	155	31	85	85	79	47	13.5	3.2	1.9	1.7	1.6	1.1	
12	0920	93	26	215	155	116	80	30.5	11.9	8.6	7.9	9.9	3.8	
15	0935	90	30	40	34	27	18	7.5	7.3	5.9	6.5	8.0	2.5	
16	0937	20	24	47	45	43.5	42	16.8	4.1	4.0	5.7	4.1	1.5	
17	0940	91	24	185	111	73	52	28.7	19.1	8.8	6.8	5.9	4.2	
19	0944	200	24	250	148	100	62	19.4	9.2	6.7	4.6	3.7	2.1	
20	0946	190	24	210	112	70	44	21.8	11.9	5.5	4.0	3.4	2.2	
22	0950	180	16	185	96	61	37	15.4	8.9	5.1	3.8	3.1	1.8	
23	1001	234	33	215	133	88	54	16.7	6.8	4.6	2.5	2.1	.95	
24	1003	210	33	140	61	43	34	24	11.1	7.5	5.0	3.5	2.2	
25	1007	155	33	180	115	81	52	19.4	14.3	8.4	7.0	5.7	2.7	
26	1008	133	33	135	80	55	37	18.9	16.7	10.8	6.9	5.9	4.3	
27	1010	115	26	195	89	57	38	25.9	10.3	15.2	7.3	9.3	4.8	
28	1013	76	26	125	96	79	56	27.4	17.5	9.2	10.3	7.0	2.9	
29	1016	82	21	25.5	17	12.8	9.2	5.2	2.6	2.1	1.35	1.35	.43	
30	1020	53	12	190	118	75	44	21.3	8.4	9.0	6.3	4.4	1.8	
31	1029	357	12	45	36	32	27	11.5	4.3	3.5	1.1	.55	.32	
42	1057	180	5	38	29	23	19	10.5	3.5	4.4	2.9	2.2	.75	
43	1119	200	6	23.5	17	14.5	12.2	8.5	6.6	3.6	3.6	2.7	1.0	

29 June 1959 - Cloud and Sky  
Frequency - Waves per Radian

Run No.	Time	Az	El	Frequency - Waves per Radian							80	100	150
				3	5	7	10	20	40	60			
44	1122	190	6	26	18	14.3	11.2	10.3	6.0	3.0	1.8	1.15	.78
45	1125	208	16	148	111	86	60	20.4	12.4	5.0	2.7	1.5	1.1
46	1128	205	16	190	93	64	48	28.7	6.0	4.8	2.5	1.5	.65
47	1145	181	16	175	93	60	33	8.9	3.5	1.6	.91	.60	.25
48	1147	195	16	190	118	82	60	38.9	39.75	25	8.5	8.7	2.8
49	1155	192	16	200	104	64	40	15.7	7.2	4.9	4.1	4.4	2.0
50	1259	185	16	78	60	49	36	17	9.5	6.6	3.8	2.9	.86
51	1301	195	16	49	46	44	41	29	13	11	4.2	2.4	2.3
52	1304	210	16	43	41	36	22	13.5	12.6	4.8	5.2	4.8	1.3
53	1307	185	16	11.2	7.8	5.9	4.4	3.2	3.6	2.3	1.85	1.15	1.3
55	1311	320	38	45	16.5	12.5	10.2	7.8	5.4	3.4	2.4	2.0	.8
56	1313	310	12	50	50	48	42	24	7.6	4.6	2.1	1.7	.78
57	1315	313	10	9.0	5.6	4.3	3.3	1.88	1.41	.83	.4	1.0	.27
58	1319	320	10	42	42	42	32	14.5	9.5	5.8	4.2	3.0	1.5
59	1322	3	11	9.8	6.0	4.1	2.5	7.8	2.5	1.7	1.0	.9	.7
60	1324	341	11	13	11.2	9.5	7.3	4.8	3.4	1.9	.85	.29	.33
62	1343	42	8	47	44	40	32	14	10	4.4	2.9	1.6	1.0
63	1346	83	6	24	22	20.5	18	7.2	7.7	6.1	1.7	.94	.39
64	1348	110	10	29	26	21	15	13.5	5.7	2.0	1.45	1.3	.36
65	1350	130	10	25	23	19.5	15	7.0	3.0	1.55	1.3	.56	.33
68	1356	86	14	180	112	74	62	40	29	16.5	15	12.5	4.8
69	1412	206	18	44	42	40	28	20	13.5	8.8	6.6	2.6	1.1
70	1415	195	20	235	130	80	48	19	10.5	7.0	6.0	5.0	1.05
71	1419	198	14	180	142	110	81	32	11.8	7.1	5.4	2.3	1.15
85	1505	90	5	13	10	8.4	6.8	5.1	3.5	1.7	1.3	1.55	.4

## 29 June 1959 - Cloud and Sky

## Frequency - Waves per Radian

Run No.	Time	Az	EI	3	5	7	10	20	40	50	80	100	150	
98	1556	18	4	29	15	9.5	6.8	4.7	5.1	4.0	1.65	1.5	.68	
101	1606	38	14	22.5	22	21	17	7.7	4.1	1.8	.55	.6	.27	
103	1610	322	11	34	27	22	17.5	10.5	5	3.6	3.4	3.0	1.7	
104	1613	85	10	18	13	10.2	8.1	4.7	3.1	2.85	2.75	1.9	.95	
105	1615	97	10	38	37	32	25.5	15	5.9	2.8	2.6	1.9	5.5	
106	1617	108	9	25	22.5	19.5	15	7	3	1.75	2.0	1.6	.58	
107	1619	92	7	40	30	22	16.5	9.4	6	4.6	2.2	2.4	.17	
108	1630	75	6	20	18	14.5	11.5	7.3	5.8	4.7	2.7	1.8	.72	
109	1632	60	6	26	21	16.5	13	6.5	5.7	3.9	2.0	1.25	.75	
110	1634	195	17	20	10	6.4	4.1	2.1	1.2	.7	.5	.38	.07	
111	1636	210	30	19	10.7	7.0	4.3	1.65	1.12	.73	.55	.40	.13	
112	1638	182	15	15	8.9	6.0	3.7	1.9	1.05	.72	.31	.175	.075	
113	1640	170	15	35	26	22	15.5	7.2	5.6	4.6	1.9	1.45	.8	
114	1641	133	18	36	30	27	18	10	4.3	2.3	1.85	1.0	.3	
115	1642	110	10	30	24	17.5	16	13.8	7.8	5.1	3.1	1.55	.9	
30 June 1959 - Clouds														
2	0836	167	16	34	22	18	14.5	9.6	7	4.1	1.75	1.3	.49	
6	0845	185	11	76	80	72	58	26	16	9.8	6.7	5.9	3.4	
7	0849	345	34	45	48	40	24.5	5.4	2.9	1.5	1.3	1.4	.31	
8	0852	320	30	27	19.5	15	11	7	4.2	2.7	1.55	1.4	.59	
9	0856	90	25	120	82	58	37	13.5	10	4.2	4.8	4.1	1.35	

30 June 1959 - Clouds  
Frequency - Waves per Radian

Run No.	Time	Az	El	3	5	7	10	20	40	60	80	100	150
10	0910	111	25	16	19	20	19	18	12	5	5.6	2	2
11	0912	145	25	76	80	70	52	32	20	6.9	6.5	7.2	2.3
12	0914	195	22	15.5	16.5	14	9.5	2.8	1.7	1.2	.52	.52	--
13	0916	240	63	23.5	19	17	11.5	5	3.2	1.1	.93	.58	.28
14	0918	180	32	18.5	18	15	.9	.24	.12	.045	.038	.021	--
19	0947	210	7	128	85	62	43	21	13.5	8	6.8	6	4.8
20	0949	225	7	28	25	22	19	12	8.3	5.7	2.6	3.8	2.3
22	0954	180	10	115	49	38	31	26	13.	9	6.3	6	3.3
24	0957	155	10	100	69	54	42	25.5	13.	9.	8.8	7.7	4.8
27	1012	70	10	155	110	85	58	25.5	13.5	8.2	6.2	5.2	2.4
55	1228	80	18	47	59	58	47	21	10	5.8	3.6	2.15	1
58	1244	110	34	51	68	67	52	19	3.9	5.6	4.8	1.77	--
59	1245	112	20	40	41	38	30	17.5	8.3	6.4	3.4	2.85	--
61	1248	115	7	27	24.5	21.5	17.5	9.6	7.2	5	3.3	2.8	--
62	1250	125	5	30	31	29	25	14.5	8	3.9	1.7	3	1.65
63	1253	126	10	2.3	2	1.6	1.05	.5	.55	.275	.155	.125	.1
65	1258	170	10	3.6	4.2	3.8	2.8	1.4	1.4	.9	.47	.34	.215
70	1320	187	55	21	9.5	6.7	4.9	3.1	1.8	1.2	.66	.87	.52
77	1350	36	14	13	7.5	5.1	3.2	1.45	.9	.36	.2	.135	.074
80	1356	183	43	14.5	9.3	6.8	4.4	1.8	.53	.46	.33	.29	.175
81	1358	187	24	6	5.7	4.8	3.5	1.9	1.4	.87	.62	.53	.3
86	1435	210	61	13.2	8.6	6	4	1.6	.96	.76	.295	.25	.155
87	1438	174	50	7	4.1	3.1	2.4	2.7	1.25	.82	.46	.45	.175
92	1459	212	12	15	10.3	7.5	5	2.1	1.13	.82	.5	.41	.185
94	1503	38	11	3.3	2.1	1.7	1.4	.99	.36	.17	.105	.059	.053

30 June 1959 - Clouds

Run No.	Time	Az	El	Frequency - Waves per Radian									
				3	5	7	10	20	40	60	80	100	150
99	1518	324	45	2.55	2.45	2.2	1.8	.89	.49	.22	.137	.072	.048
103	1528	204	18	4.6	4.1	3.6	2.95	1.8	1.5	.53	.46	.3	.265
104	1531	200	24	5.7	5.5	5	4.1	2.05	1.6	.91	.5	.35	.21

30 June 1959 - Blue Sky

33	1040	140	10	26.5	30	29	25	16.7	5.1	3.5	1.75	1.25	.65
34	1041	140	20	17.7	18	17	14.7	9.5	6.2	1.35	1.62	1.25	--
35	1043	140	40	3.2	3	2.25	1.23	.295	.077	.0165	.0057	.0046	--
36	1044	145	60	6.3	6.2	4.8	2.75	.59	.15	.02	--	--	--
37	1045	145	80	1.18	2	.95	.56	.116	.062	.03	.0104	.0084	--
38	1046	90	9.5	10.3	9	6.3	2	.74	.208	.145	.11	.068	
39	1048	330	80	10	10	8	4.6	.67	.24	.116	.059	.027	--
40	1049	330	60	5.2	4.7	3.5	1.8	.37	.177	.094	.072	.051	.047
41	1052	335	40	4.5	4.5	3.8	2.2	.37	.035	.019	.01	--	--
42	1054	335	20	7.8	7.1	5.2	2.9	.51	.166	.105	.025	.009	--
43	1056	335	5	10.8	8.7	5.9	3.3	.75	.29	.164	.11	.07	--

30 June 1959 - Cloud and Sky

1	0834	185	16	153	70	50	40	31	18.5	11.7	8.8	7.6	6.3
3	0839	155	16	170	108	74	46	18	10	7.8	8.3	8.2	5.2
4	0841	210	11	45	54	53	44	20	3.8	1.5	2.25	1.3	--
5	0843	190	11	210	117	77	50	26.5	13.5	8.5	5.2	5.5	3.4
15	0920	135	18	147	107	78	51	22.5	14.3	12	7.4	7.3	--
16	0923	128	15	130	94	72	49	19.5	10	7	6.2	5.9	4.9
17	0943	220	18	150	80	54	36	19	14	8.1	6.7	5.2	2.5
18	0945	217	11	70	65	58	48	33	20	8.4	7.9	6.1	4.8

30 June 1959 - Cloud and Sky  
Frequency - Waves per Radian

Run No.	Time	Az	EI	3	5	7	10	20	40	60	100	150
21	0952	195	10	120	67	49	37	19	9	7	5.4	5
23	0955	170	10	61	72	67	47	19.5	10.8	8.8	6.8	6
25	1008	145	10	52	45	40	33	20.5	10.5	8	7.5	5.2
26	1010	75	10	133	95	74	55	30	19	7.4	4.3	3.4
28	1014	60	10	153	96	67	44	18.5	10	5.7	7.6	6.2
29	1017	80	10	180	68	43	32	27	10	4.3	1.75	1.7
30	1019	75	8	133	79	54	35	15	12.5	4.6	3.8	2.8
31	1022	55	8	190	120	82	51	24	13.5	7.3	6.5	5.3
32	1024	100	15	45	56	58	50	24	11.5	5.4	2.3	1.15
44	1107	8	7	45	50	46	37	20	19.5	5.5	5.1	2.3
45	1111	15	10	43	56	56	46	19	13	6.8	6.4	5.5
46	1114	358	10	13.7	14.5	14	13.2	12.8	8.8	4.7	2.8	3.3
47	1116	20	8	41	52	49	38	25.5	15	13	6.6	4.4
48	1118	20	15	180	143	90	48	26	11.5	8.2	4	2.8
49	1121	20	16	132	90	68	47	23	16.5	10.7	7.8	6.2
50	1123	26	8	121	105	74	41	29	21	7	6	4.2
51	1125	48	16	67	68	60	44	20	8	4.1	3.1	2.15
52	1222	55	23	49	41	34	26	13	7.5	4	2	1.15
53	1224	50	8	82	67	52	36	14	5.6	2.55	1.9	1.35
54	1226	70	8	50	39	37	36	36	27	9.6	8	5.5
56	1231	65	45	26	17	12	8	3	1.5	1.25	.5	.3
57	1238	102	47	220	130	88	54	20	11.3	10.7	5.5	5
60	1246	118	20	41	51	50	43	17	6.7	3.6	2.5	2.05
64	1255	155	16	9.6	9.6	6.3	3.1	2.85	1.3	.4	.65	.59
66	1312	200	37	18.3	10	7	5	2.5	1.12	1.08	1.65	1.68
67	1314	212	42	21	14	8.7	4.6	3.5	1.3	.9	.85	.61

30 June 1959 - Cloud and Sky  
Frequency - Waves per Radian

Run No.	Time	Az	EI	3	5	7	10	20	40	60	80	100	150
68	1316	240	48	21	12.5	8.4	5.4	2.3	1.05	.39	.26	.16	.42
69	1318	240	64	12.5	9.5	7.7	5.8	3.1	1.5	1.3	.53	.38	.29
71	1322	205	42	3.8	5	5.2	4.5	2.1	.93	.29	.235	.2	.12
72	1327	225	43	19	11	7.4	4.4	1.33	.46	.275	.175	.22	.12
73	1330	240	38	18	9	7	5.3	3.2	2	1.3	1.04	1	.81
74	1343	39	33	22	10.3	6.5	4.1	1.9	.83	.46	.16	.125	.095
75	1345	45	22	2.75	3.5	3.5	2.75	1.1	.82	.45	.33	.215	.167
76	1348	47	17	12.2	7.8	5.6	4	2.05	1.27	.8	.65	.53	.14
78	1352	10	13	13.3	8.8	6.5	4.5	2.2	.88	.54	.51	.43	.19
79	1354	95	17	4.6	4.5	3.8	2.7	2.4	1.15	.78	.44	.45	.3
82	1425	246	40	.71	.86	.8	.6	.19	.1	.25	.26	.24	.13
83	1427	294	45	.41	.47	.43	.32	.15	.103	.068	.076	.071	.00
84	1430	228	72	7.6	5.8	4.8	3.9	2.4	1.8	1.9	.83	.65	.78
85	1433	222	51	11.8	7.1	5.6	4.4	3	2	.52	.89	.8	.6
88	1440	197	28	13.2	5.4	3.2	1.95	.98	.73	.225	.28	.28	.17
89	1443	165	28	5.3	6.4	6.3	5.1	2.65	1.07	1.05	.35	.42	.35
90	1454	170	23	17.5	10	6.8	4.3	1.75	.85	.45	.43	.33	.23
91	1457	135	23	2.75	3.4	3	2.05	1.2	.87	.66	.36	.28	
93	1501	.95	11	10.7	7.5	5.8	4.5	2.65	1.7	.88	.97	.73	.27
95	1505	0	14	3.5	3.5	2.9	1.95	.68	.61	.23	.19	.18	.084
96	1506	344	14	17.6	10	6.5	4.1	2	1.15	.63	.64	.295	.185
97	1508	348	14	6	5.3	4.5	3.5	1.8	1.12	.63	.62	.5	.28
98	1516	345	14	4.6	4.9	4.7	4	3.1	1.5	.75	.65	.46	.19
99	1520	220	37	15.3	7.5	5	3.4	1.85	1.25	.64	.72	.73	.69
101	1524	182	39	8.6	8.1	6.8	4.8	1.75	1.37	.7	.58	.65	.42
102	1526	212	17	6.9	5.4	4.3	3.2	2.2	1.75	1.15	.67	.5	.38
105	1533	222	22	1.43	1.2	1	.75	.37	.2	.133	.105	.09	.07